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Complete Specification entitled (54) HYDROFOIL SAILING BOAT.

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Applicant (71) AMIRAM STEINBERG.

Actual Inventor (72) AMIRAM STEINBERG.

Related Art (56)

57,456/65	92. 6; 91. 6.
59,909/65	92. 6; 91. 6.

The following statement is a full description of this invention, including the best method of performing it known to me

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This invention relates to a hydrofoil boat, and more particularly to a sail boat equipped with a hydrofoil having stabilizing and lift ailerons.

In the past efforts have been made to equip sailboats and other small craft with hydrofoils which function to support the hull of the boat above water in order to reduce resistance and thereby substantially increase speed. In the case of sailboats, the transverse wind forces on the rigging, as well as the weight of the mast and sail, necessitate some sort of counterbalancing means to prevent the boat from tipping over particularly when sailing on its hydrofoil.

In order to provide such stability, it has been suggested to design hydrofoils of sailboats with extremely wide bases for support and with various complicated mechanisms to provide stability in addition to widening the base of support. However, to date, such type of hydrofoil sailboats have been impractical for many reasons, including lack of stability and insufficient manoeuvrability characteristics, and also size of foils needed, etc.

Hence it is an object of this invention to provide a sailboat having hydrofoil which include ailerons which operate automatically in response to the transverse wind forces to compensate for and counterbalance such forces and stabilize the boat under all operating conditions.

The riggings and mast of a sailboat react to the transverse wind forces and respond to variations thereof. Such response consists, for example, in a slight deflection of the mast from the windward to the leeward side of the

boat, an increase or decrease of the pull of the anchorings of the main sheet pulleys and of the pull on the gib mountings, etc. In accordance with the present invention, use is made of such a reaction of the mast and rigging of a hydrofoil sailboat for stabilizing the boat.

The invention consists in a sailboat comprising a hull having a mast upon which a sail is mounted and at least one hydrofoil extending transversely beneath the hull, characterized in that at least one hydrofoil is fitted with at least one pair of ailerons hingedly connected to the tail side thereof with one of each pair located on opposite sides of the longitudinal centre line of the boat, each of the ailerons being linked by mechanical means and a control mechanism to a component of the rigging in such a manner that when the transverse wind force on the boat changes one aileron is raised and the other lowered so that the boat remains transversally balanced.

Where use is made of the reaction of the mast to the transverse wind forces it is possible to utilize the natural elastic deflection of the mast. Alternatively, it is possible to anchor the mast in such a manner as to be somewhat tiltable between two extreme positions and to make use of these tilts.

If desired, any pair of ailerons may in addition be adapted for a controlled joint movement. In this way both ailerons may be lowered jointly for increasing the lift during the take-off of the hull from the water, whereby the take-off is assisted, and be raised jointly as the boat picks up speed, and thus serve as flaps.

The invention is illustrated, by way of example only, in the accompanying drawings in which:

Fig. 1 is an elevational view of a hydrofoil sailboat according to the invention;

Fig. 2 is a cross-sectional view of a portion of the sailboat taken along line II-II of Fig. 1, drawn to a larger scale;

Fig. 3 is a perspective view of the hydrofoil construction;

Fig. 4 is a perspective view of the rear of the sailboat, showing the rear supporting hydrofoil and rudder;

Fig. 5 is a schematic perspective view of one embodiment of the control mechanism for operating the ailerons;

Fig. 6 is a schematic perspective view of another embodiment of the control mechanism for operating the ailerons;

Fig. 7 is a fragmentary representation of means for the control of the transmission ratio in dependence on the angular position of the boom in the embodiment of Fig. 6; and

Fig. 8, 9 and 10 show the sailboat in three different sailing conditions and are schematical views as if taken from the bow direction.

As shown in Figs. 1 to 4, the hydrofoil sailboat 10 according to the invention comprises a hull 11 and a mast 12 having a swingable boom 13 which together carry the main sail 14. As is conventional, the main sail is controlled by a main sheet 15.

A jib 16 is shown mounted upon the forestay as is conventionally found on sloop rigged boats, e.g. of the Marcony type rigging. There are further provided shrouds 17 connected at their upper ends 18 to the mast 12. The mounting of the lower ends of the shrouds will be described below.

Beneath hull 11 is mounted a fore hydrofoil assembly 20 whose structure is more closely illustrated in Figs, 2 and 3. As shown, it includes a vertical centre support 21 at whose lower end the hydrofoil 22 is secured. Upwardly bent stabilizer foils 23 extend outwardly and upwardly from the opposite ends of the hydrofoil portion 22 and side supports 24 support the sides of the hydrofoil and interconnect them with the side portions of the hull 11. As can be seen, the hydrofoil assembly 20 is located approximately beneath the mast and its span is not much wider than the beam of the boat. A pair of ailerons 25 are hingedly connected at 26 to the tail side of the hydrofoil 22.

A further rear hydrofoil assembly 27 is mounted below the stern end of the boat. The structure of assembly 27 is more closely illustrated in Fig. 4. As shown, it comprises a centre support 28 to which the rudder 29 is hingedly connected with the tiller 30 being above the deck of the boat for control. To the lower end of support 28 is secured a hydrofoil 31 which includes stabilizer foils 32 at its opposite ends. Side supports 33 connect the ends of the hydrofoil to the sides of the hull.

Ailerons may be included in this construction where desired, and where necessary due to the size of the boat,

but for illustrative purposes no reference to such ailerons is shown in the embodiment here illustrated.

One embodiment of the control mechanism of the two ailerons 25 is illustrated in Fig. 5. In this figure the vertical centre support 21 has been omitted for the sake of clarilty. By means of this mechanism the ailerons are controlled for joint movement upwardly and downwardly, particularly downwardly, to increase lift when needed as well as to operate independently, but oppositely, with one going up and the other going down, to provide transverse stabilization when the hull is out of the water. As shown, the control means for operating the stabilizers include a control drum 35 having fastener pins 36 secured on one face thereof to which are connected stiff control rods 37 whose lower ends are connected by pins 38 to each of the ailerons 25.

The control drum 35 is rotatably mounted upon shaft 39 supported by bearings 40 which in turn are supported by springs 41 having their lower edges joined to brackets 42. The brackets which are fixed to the hull of the boat are provided with guide slots 43 for guiding the ends of the shaft 39 for upward and downward movement only, against the resistance of the springs 41, which normally pull the shaft downwards.

A pulley 45 rotatably mounted upon a shaft 46, secured to the hull of the boat (by mountings not shown) is connected to the control drum 35 by means of a belt 47. Preferably, the pulley as well as the control drum is provided with teeth, like sprockets, and the belt 47 is also

toothed for more positive drive.

The lower ends of the shrouds 17 pass about pulleys 48 secured at opposite sides of the hull and then extend downwardly and are connected together at 49 to a

point on the belt 47.

At the beginning of the operation ailerons 25 are horizontally aligned and are pushed downward by the action of springs 41 on shaft 39. This is the take-off position shown in Fig. 8 in which the hull of the boat is riding in the water. In this manner the ailerons increase the lift and assist in the take-off of the hull from the water as the speed of the boat increases.

As the boat picks up speed and begins to ride upon the foils, as schematically shown in Fig. 9, the water pressure against the ailerons 25 forces them upwardly towards complete or near complete alignment with the hydrofoil 22. As the ailerons move upward, they force the rods 37 upward which, in turn, force the control drum 35 with its shaft 39 upward against the pull of springs 41.

Now, with the boat riding upon its hydrofoil the force of the wind upon the sail will cause the mast 27 to shift away from the wind. The movement of the mast may be accomplished by mounting the mast pivotally at its lower end for such movement or the mast may be slightly flexible so that it bends as many masts commonly do. As the top of the mast moves away from centre, it exerts a pull on the shroud 17 on the windward side while the shroud 17 on the leeward side tends to become slackened. (See the arrows in Fig. 5 and also Fig. 10).

The difference in tension in the two shrouds, that is, the pull on the windward shroud as compared with the slackening on the leeward shroud, causes the shrouds to move and thereby causes the belt 49 to move with the shrouds to which it is connected. This rotates the control drum 35 to

force one of the rods 37 downwardly, while pulling the other one upwardly, thereby lowering one aileron and raising the other (see Fig. 10) a sufficient amount to counterbalance the force of the wind and thereby to stabilize the boat and permit it to sail at high speed upon the hydrofoil.

As the force upon the mast, that is, the wind force upon the sail increases, the ailerons will further move apart and as the force decreases, the ailerons will automatically move towards alignment with the hydrofoil. Hence, it can be seen that the ailerons automatically respond to the varying force upon the mast to stabilize the boat at all times, even under gusty conditions and the like.

Even while the hull is in the water, the ailerons can also oppositely act as well as be moved jointly downwardly, to stabilize the boat as well as at the same time increase the lift for take-off.

The specific hydrofoil construction illustrated above was shown by way of example only. While their form seems to be suitable for the type of craft illustrated, namely, a relatively small sailboat, other hydrofoil forms may be desired for other size and shape boats, but utilizing the invention herein, namely, an aileron construction as described above.

A further embodiment of the control mechanism of the two ailerons 25 is illustrated in Figs 6 and 7. Like in the case of Fig. 5, the vertical centre support 21 has been omitted for the sake of clarity of illustration. Those members of the embodiment of Figs. 6 and 7 which are the same as in the embodiment of Fig. 5 are designated by the same numerals.

In the embodiment illustrated in Figs. 6 and 7 each control rod 37 is linked to a vertical rack 51 and both racks are commonly engaged by a pinion 52 keyed on a shaft 53, one end of which is journalled in the rear wall of a block 54 while the journalling of the other end is not shown. Each of racks 51 is slidable within an associated groove of block 54 and the block in turn is mounted in a vertically slidable manner within a stationary frame 55 and comprises two ridges 70 which engage correspondingly shaped grooves 57 of the frame. Block 54 rests on compression springs 56 only one of which is shown. The block can be pulled downwards against the action of the springs by means of a cable 58 operable in a suitable manner from within the boat.

Integral with shaft 53 is a substantially upright rod 59 having a collar 60 and slidably mounted thereon a ball 61 resting on a compression spring 62 which in turn is supported by collar 60. If desired, pinion 52 may form part of a gear mechanism whose power input gear is connected to said rod 59.

The upper portion 63 of frame 55 comprises a channel-like hollow space housing an inverted U-shaped shiftable member 64. On both its lateral sides member 64 comprises lugs 65 by means of which it is connected to cables 66 which are designed to react to the transverse wind force on the sail and may, for example, correspond to shrouds 17 of Fig. 5, or be linked to any other component of the rigging. In this manner the shiftable member 64 is displaced horizontally each time the transverse wind force on the sail changes.

The displaceable ball 61 is linked by means of a bowden-wire-type cable 67 to a bracket 68 of the mast 52 which in this case is turnable about its axis. Consequently, whenever the angle α between sail 14 and the course of sailing changes

wire 67 is either pulled or slackened, as the case may be. The above angle α is dependent on the angle between the wind direction and the course of sailing. Quite generally, it is possible to connect cable 67 to any part of the rigging, inherent or specially designed, whose position is dependent on the angle between the wind direction and the course of sailing.

The joint upward and downward movement of ailerons 25 in this embodiment is achieved by pulling or releasing cable 58. If cable 58 is pulled, block 54 is lowered against the action of springs 56. Since shaft 53 is journalled in that block it is lowered together therewith and consequently the racks 51 are equally lowered with the result that rods 37 are pushed downwards and ailerons 25 are lowered. When the pull of cable 58 is released block 54 returns to its starting position by the action of the springs 56. Thus, like in the embodiment of Fig. 5, the ailerons can be lowered jointly to increase the lift during the take-off and thereby serve as flaps.

When during sailing the transversal wind force on sail 14 changes the pull on one of the cables 66 will be greater than that on the other one and, consequently, the shiftable member 64 will move laterally either direction, depending on the direction of the change. When this happens member 64 will abut ball 61 and in consequence rod 69 is shifted whereby shaft 53 and with it pinion 52 are turned. This in turn causes a raising of one of racks 51 and the associated rod 37 and the lowering of the other one. In this manner one of the ailerons 25 is lowered and the other one is raised and the boat remains transversally balanced.

It is a further characteristic of the embodiment of Figs. 6 and 7that the ratio between the linear displacement of member 64 and the resulting angular displacement of rod 59 and shaft 53 is changed in dependence on the angle α between sail 14 and the course of sailing. This change is automatically achieved by the connection by means of the bowden-wire-type cable 67 between mast 12 and ball 61. It is seen from Fig. 7 that as the angle α increases cable 67 is pulled and ball 61 is lowered against the action of spring 62 whereby the ratio between the linear and angular displacement is increased, meaning that each unit linear displacement of member 64 causes a relatively larger angular displacement of shaft 53. Vice versa, as the angle α decreases ball 61 is raised by the action of spring 62 and the above ratio is accordingly decreased. In this manner there is obtained a fine adjustment of the automatic stabilization achieved in accordance with the present invention.

Although in the embodiments of the invention illustrated in the accompanying drawings and hereinbefore described the ailerons are also designed for joint movement so as also to serve as flaps, this is not essential and it is possible in accordance with the invention to provide ailerons on the hydrofoils which are only designed for movement in opposite directions and thus serve only for transversal stabilization. In other words, the flap character of the ailerons is optional.

The claims defining the invention are as follows:--

1. A sailboat comprising a hull having a mast upon which a sail is mounted and at least one hydrofoil extending transversally beneath the hull, characterized in that at least one hydrofoil is fitted with at least one pair of ailerons hingedly connected to the tail side thereof with one of each pair located on opposite sides of the longitudinal centre line of the boat, each of the ailerons being linked by mechanical means and a control mechanism to a component of the rigging in such a manner that when the transverse wind force on the boat changes one aileron is raised and the other is lowered so that the boat remains transversally balanced.

2. A sailboat according to Claim 1, characterized in that said mechanical means comprise a pair of cables extending in opposite directions from said control mechanism.

3. A sailboat according to Claim 2, characterized in that said cables are shrouds linking said control mechanism with the mast.

4. A sailboat according to Claim 3, characterized in that the mast is anchored in such a manner as to be tiltable between two extreme positions.

5. A sailboat according to any one of the preceding Claims, characterized in that at least one pair of

ailerons is adapted for a controlled joint movement thereby to act as flaps.

6. A sailboat according to any one of the preceding Claims, characterized in that said control means comprise a rotatable member keyed on a substantially horizontal shaft, which member is adapted for angular displacement by said mechanical means and is linked by means of rigid linking means to the ailerons in such a manner that upon an angular displacement of the member one aileron is raised and the other is lowered.

7. A sailboat according to Claim 6 when appended to Claim 5 characterized in that the ends of said shaft of the rotatable member are received by substantially vertical guide slots and the shaft is biassed downwards.

8. A sailboat according to any one of Claims 1 to 5, characterized in that said control mechanism comprises a gear mechanism comprising a pinion keyed on a substantially horizontal shaft within a vertically displaceable block and being adapted for angular displacement by said power transmission means, and a pair of racks engaging said pinion at opposite sides thereof, each of said racks being vertically displaceable within said block and linked by means of rigid linking means to one aileron.

9. A sailboat according to Claim 8, characterized in that said gear mechanism has a power intake gear which is

connected to or integral with a substantially upright rod whose upper end cooperates with a substantially horizontal shiftable member controlled by said mechanical means.

10. A sailboat according to Claim 9, characterized in that said pinion also serves as said power intake gear and said substantially upright rod is connected to or integral with the shaft thereof.

11. A sailboat according to Claims 9 or 10, characterized in that said substantially upright rod comprises an upwardly biassed, vertically displaceable member received by a suitable cavity of said horizontally shiftable member, which vertically displaceable member is linked to a component of the rigging whose position is dependent on the angle between the wind direction and the course of sailing in such a manner that as this angle increases said vertically displaceable member is lowered whereby the degree of angular displacement of said substantially upright shaft corresponding to a unit linear displacement of said horizontally shiftable member is increased.

12. A sailboat according to Claim 1, substantially as described hereinbefore with reference to any one of Figs. 1-4 and 8-10.

13. A sailboat according to Claim 1, comprising a control mechanism substantially as described with reference to Fig. 5.

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14. A sailboat according to Claim 1, comprising a control mechanism substantially as described with reference to Figs. 6 and 7.

Dated this 17th day of May, 1967.

AMIRAM STEINBERG
by his Patent Attorneys
DAVIES & COLLISON.

Fig. 1.

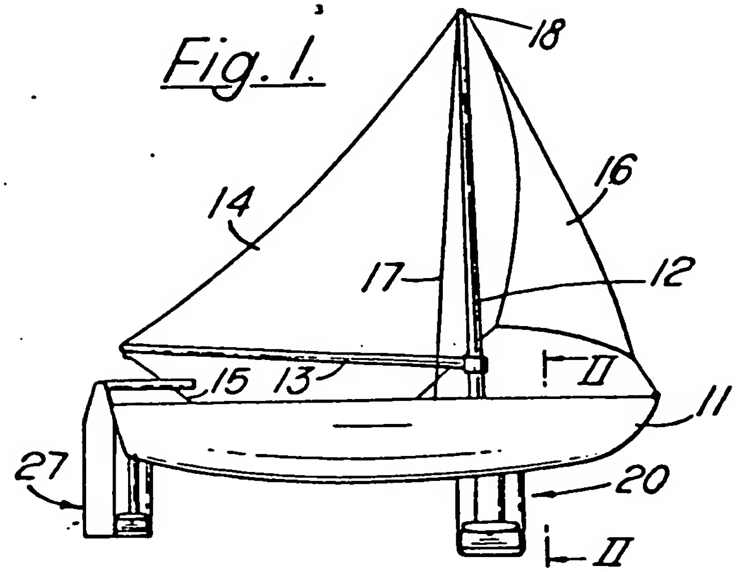


Fig. 2.

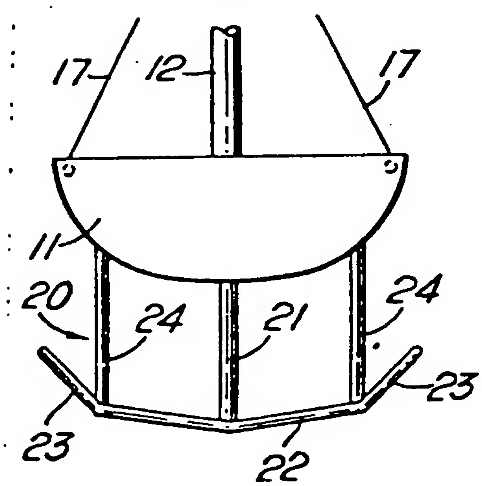


Fig. 3.

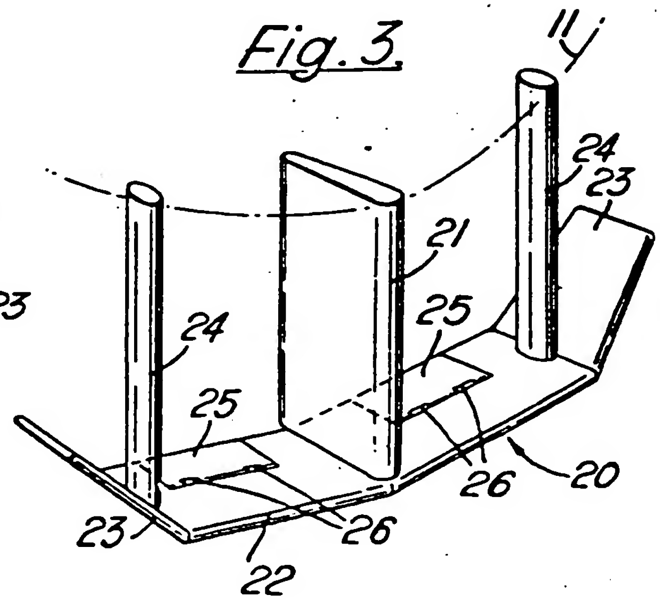
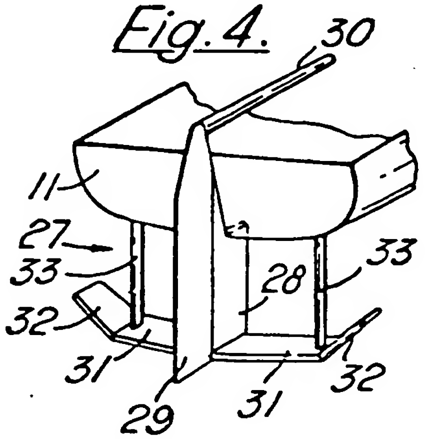


Fig. 4.



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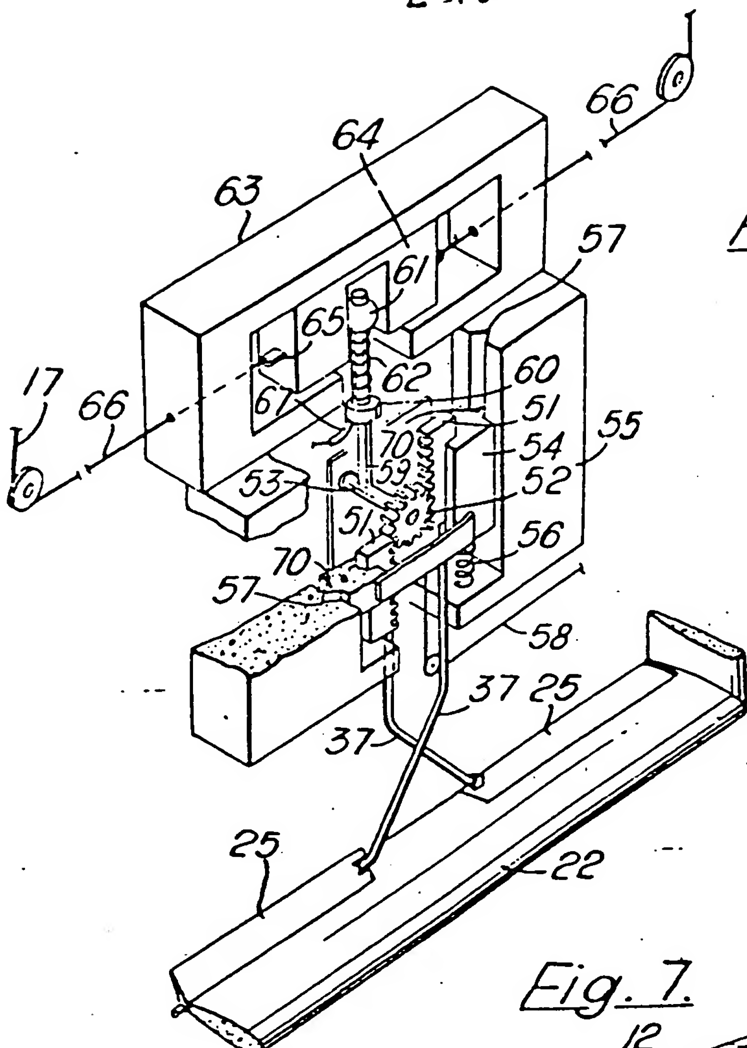

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Fig. 6.

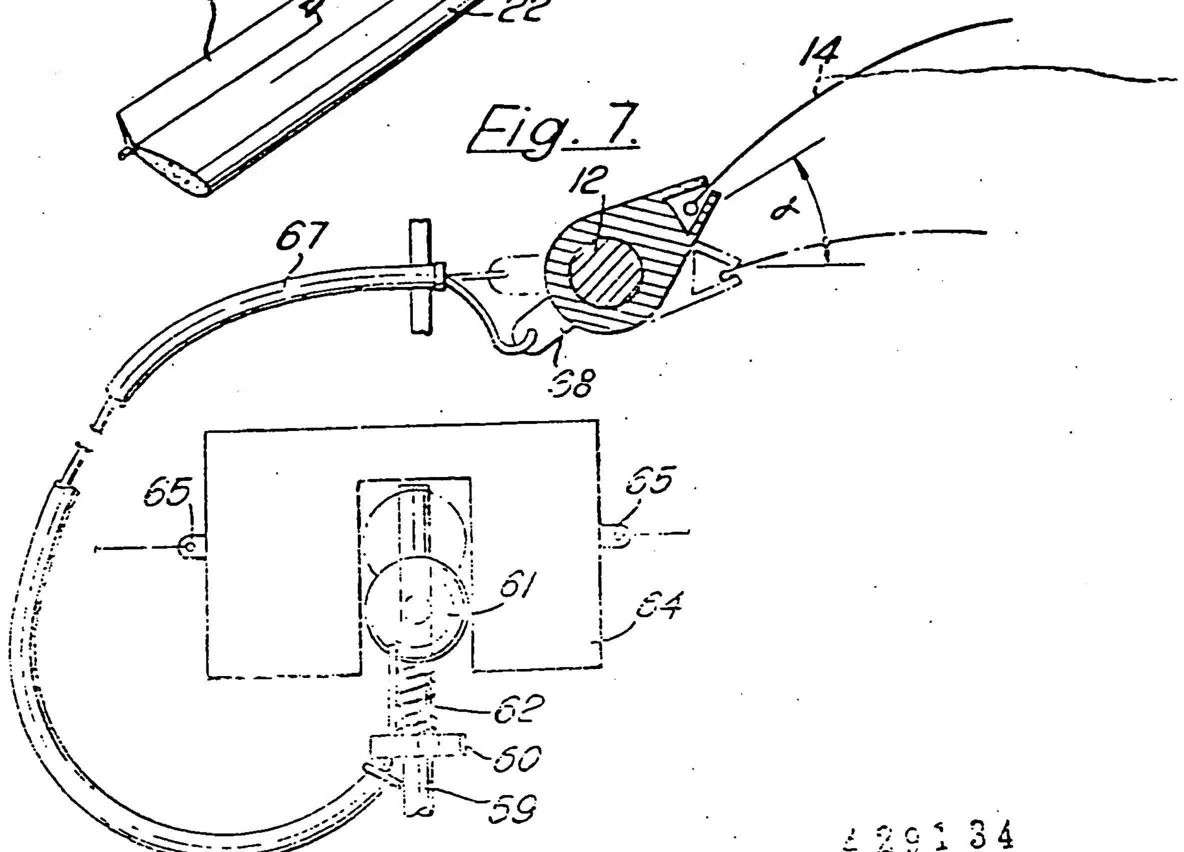

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Fig. 7.

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Fig. 5.

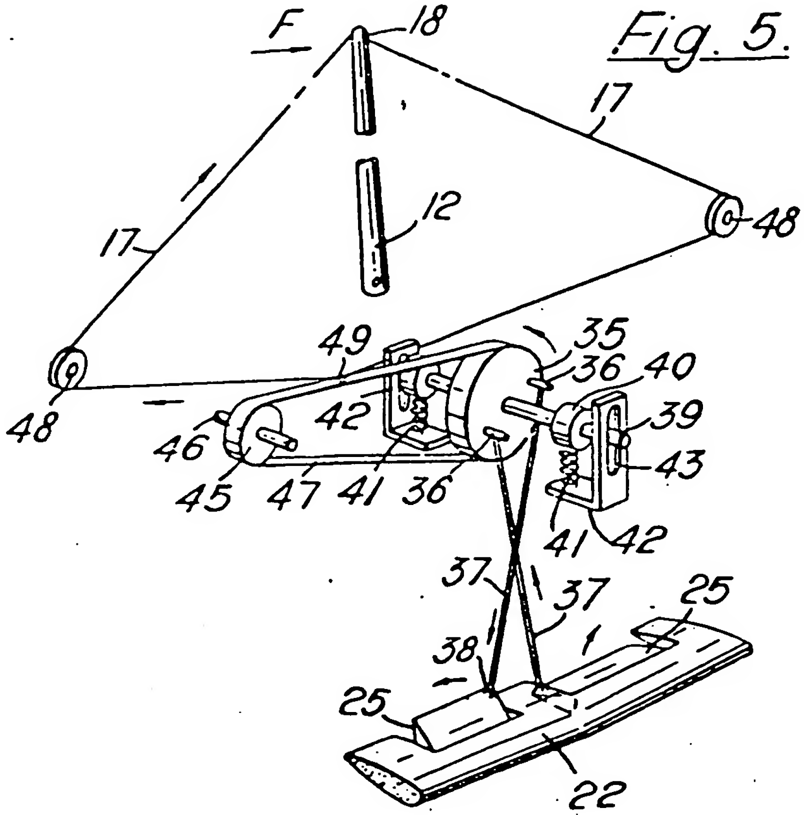


Fig. 8.

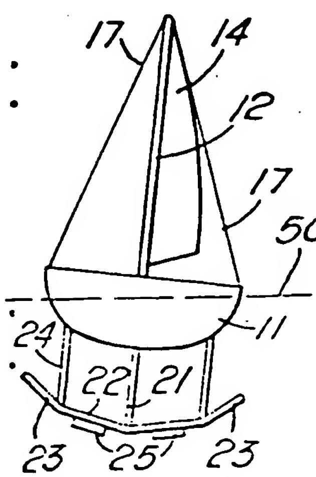


Fig. 9.

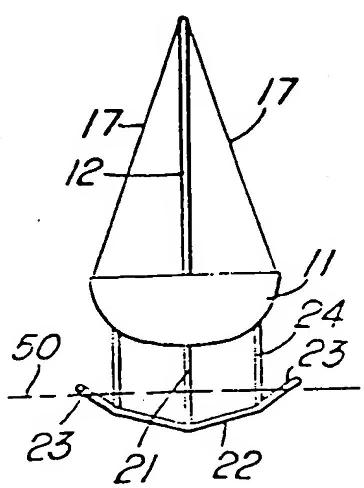
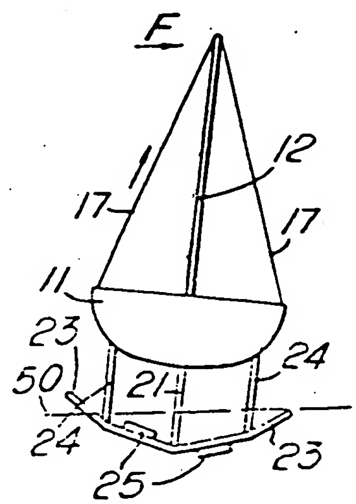


Fig. 10.



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